Measurement of Radionuclides Using Ion Chromatography and Flow-Cell Scintillation Counting

Developer: South Carolina Universities Research and Education Foundation
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Crosscutting Area: CMST

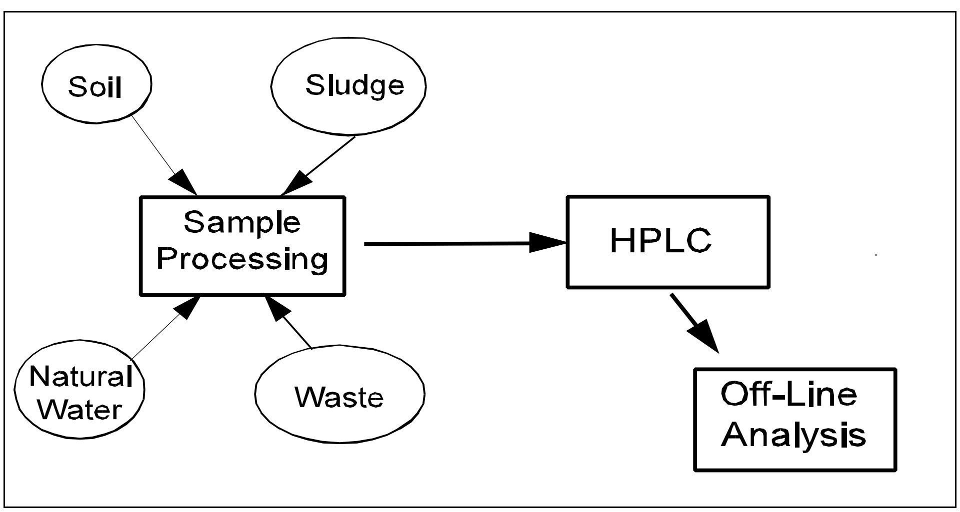
Subsurface Contaminants FOCUS AREA

Problem:

Radiological characterization and monitoring is an important component of environmental management activities throughout the Department of Energy (DOE) complex. Radionuclides which cannot easily be detected by gamma-ray spectroscopy, such as pure beta emitters and transuranics, pose special problems because their quantification generally requires labor intensive radiochemical separations procedures that are time consuming and not practical for field applications.

Solution:

A technology that can measure transuranics and pure beta emitters relatively quickly and has the potential of being field-deployable. This technology combines high-performance liquid chromatography and on-line scintillation counting with alpha/beta pulse shape discrimination. The ability to measure pure beta emitters such as Strontium (^{90}Sr), Technetium (^{99}Tc), and Nickel (^{63}Ni) and actinides/transuranics such as Thorium (^{232}Th), Uranium (^{233}U), Neptunium (^{237}Np), Plutonium (^{239}Pu), Americium (^{241}Am), and Curium (^{244}Cm) has been demonstrated. Up to this point, work has been primarily limited to aqueous samples of relatively high purity and to radionuclide concentrations that are representative of many waste applications, but are higher than those typically encountered in environmental cleanup applications. For the technique to be useful in applications involving complex matrices such as sludge and soil, research is needed in sample preparation and processing to remove chemical and radiological interferences. For the technique to be useful at typical environmental levels, research is needed to lower detection limits. This project addresses these research needs.



Benefits:

- Analysis of alpha emitters and pure beta emitters in environmental samples or waste samples
- Radionuclide-specific measurements in a relatively short period of time (< 4 hours)
- Elemental and some isotopic selectivity
- On-line minimum detectable concentrations on the order of 0.4 to 4 kBq/m^3 (10 to 100 pCi/g)
- Potentially field deployable

Technology:

The project has three main components; one to lower the radiation detection limits, another to identify chemical and radiological interferences, and the last to determine sample processing protocols. The components are focused on sample types and radionuclides that are relevant in DOE applications. Although efforts will be initially directed toward development of the technique as a screening tool, it has the potential to be able to measure many radioactive elements at regulatory levels.

The research effort is centered around the analysis technique, which combines high-performance liquid chromatography and on-line scintillation counting. Radionuclides in ionic form in an aqueous solution are concentrated on an ion-exchange column and subsequently removed to a separation column with chemical eluents. Through the selection and sequencing of the eluents, chromatographic separation of the constituents is achieved. A chromatogram of radioactive constituents is then produced by an on-line scintillation counter. For very low-level applications, fractions containing selected radioelements can be collected and counted off-line.

The basic instrumentation for this analysis technique is available under the trade name ANABET (ANalysis of Alpha, Beta, and Electron capture Technology) through Bradtec-GB, Inc. The effort to lower detection limits will focus on background reduction. This will be accomplished through a combination of coincidence counting, anti coincidence shielding, and pulse shape discrimination to distinguish between alpha pulses and beta/gamma pulses.

Sample preparation procedures and processing will be developed based on quantified chemical and radiological interferences. A simple matrix (groundwater) and two complex matrices (a soil and a waste-tank supernatant). For each sample, the potential chemical and radiological interferences were identified and the concentrations at which they interfere with either the chromatographic separation or with radiation detection were determined. These concentration limits are the target criteria for the development of sample-preparation techniques.

Contacts:

South Carolina Universities Research and Education Foundation is a consortium of southeastern universities with extensive experience in nuclear engineering. This project is supported by Clemson University and Rust Remedial Services, Inc.-Clemson Technical Center. Bradtec-GB is an industrial partner for the project. For information on this project, the contractor contact is:

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